THE DESIGN AND APPLICATION OF A DECISION-MAKING SCHEMA CONCERNING IMPLEMENTATION OF COMPUTER-ASSISTED INSTRUCTION IN BACCALAUREATE SCHOOLS OF NURSING

by

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CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

Nurse educators are being forced to reexamine critically their instructional programs and practices because of a rapidly expanding knowledge and skill base, progressive applications of technological innovations in the clinical practice area, a limited faculty pool, faculty workload issues, declining student enrollments and increasing student diversity, increasing program accountability, and the restriction of financial resources (Kemp, 1977; Lambertsen, 1966; National League for Nursing <u>Nursing Data Book--1979</u>, 1980; Ozimek and Yura, 1977; Johnson, 1980; Willman, 1976; Brown, 1980; Brown, 1977). The rapid technological advances in computing and extensive capabilities of computers strongly suggest that they be used in enhancing learning and thought and be considered as one approach to address the pressures cited above. Specifically, computer-assisted instruction (CAI) may enhance the effectiveness and efficiency of learning and teaching in baccalaureate schools of nursing. For the purposes of this study, CAI will be defined as:

> a teaching process directly involving the computer in the presentation of instructional materials in an interactive mode to provide and control the individualized learning environment for each individual student. These interactive modes are usually divided into drill-and-practice, tutorial, simulations and gaming . . . (Splittgerber, 1979).

Based upon her prediction that the majority of nursing education courses will be computerized within the next few decades, Silva (1973) cautions nurse educators against rapid and unplanned entry into CAI. She stresses that critical questions concerning the nature of nursing and of the learner, the teacher, and the teacher-learning process must be addressed, and she suggests that:

> Nurse educators of today must therefore consider carefully the foundations on which they postulate computer curriculums. Checks and balances must be built into the design to detect error of content and to prevent continuous unchecked growth. And, to prevent faculty disengagement, nurse educators must explore methods by which the majority of nurses who do not directly confer with educational computer firms will still feel that they are a viable part of curriculum planning.

In essence, Silva focuses attention on the need for utilization of a cybernetic systems model for decision-making in regard to CAI.

A review of the literature concerning the reported applications of CAI in nursing reveals that use of a cybernetic systems model for decision-making is strikingly absent. Sporadic, partial development of computer-related curriculum by one faculty member or a small group of faculty without overall program coordination has been the rule rather than the exception.

A need exists to develop a decision-making model or schema to facilitate optimal decisions concerning program-wide applications of CAI in schools of nursing. This need is enhanced by the newness of computer technology in nursing education. Few nurse educators have expertise in this area; therefore, few are even aware of questions which should be asked or the potential array of options which are available.

Background

Johnson (1980) provides a comprehensive view of the current status of instructional computing in higher education based on survey data from several thousand department heads and instructors in ten disciplines of higher education (exclusive of nursing). He draws four conclusions about instructional computing:

1. The computer is an integral part of higher education only in those disciplines where it is a required skill for postbaccalaureate work.

2. The computer as a teaching aid is not widely used in higher education; but interest in applications such as tutorial materials in mathematics is growing.

3. A significant number of schools make little or no use of computing in undergraduate instruction.

4. While there are amazing similarities across academic disciplines in the problems in attempting to use instructional computing, such as lack of training, lack of time, use as a tool rather than a teacher, there are also differences in when and how computing is used.

Johnson concluded that there are three basic reasons for the low level of use of computing in higher education:

1. Computing equipment and software currently in place for instructional use is barely adequate for moderate use and inadequate for extensive use.

2. Effective instructional software is increasingly the major factor in using the computer in teaching. To date not much is available.

3. Among those institutions not using the computer today, lack of faculty training is cited as the most important reason.

Despite the seemingly gloomy status and serious barriers to the use of instructional computing, Johnson reported that an overwhelming number of department heads and instructors who were surveyed see their use of instructional computing increasing in the future.

The reported applications of instructional computing in nursing parallel the status in higher education reported by Johnson. A survey of 200 schools of nursing (with 155 reporting) indicated that 11 (7 percent) were using CAI to some degree. Seventy-three other schools indicated that they were at various stages of considering the adoption of CAI. Main impediments to the use of CAI indicated by survey respondents were deficiencies of funds, courses (software), and faculty expertise (Levine and Wiener, 1975).

Elmore (1974) conducted an extensive survey study "to identify the problems and issues of introducing computer/electronic data processing technology into NLN accredited baccalaureate nursing programs." The population of the study was 208 NLN accredited baccalaureate nursing programs (with 96 percent responding). Major findings about the state-of-the-art of computer/electronic data processing applications were:

1. NLN accredited baccalaureate nursing programs are just beginning to use computer/electronic data processing applications.

2. Privately controlled programs tend to have more uses and applications than publicly controlled programs.

3. Larger programs, on the whole, have more extensive use than smaller ones.

4. Records of faculty and students comprise the largest group of non-clinical computer uses; research is second, followed by testing. Instructional uses and simulation are at the bottom of the list.

5. There are fewer clinical applications and no difference between public and private control, nor does size seem to be significant. The differences have more to do with the size of the hospital than the size of the nursing program. Only 1 in 3 nursing students is getting exposure to clinical computer applications.

6. Most faculty and students use the computer center for non-clinical computer applications, having only limited access to computer services in classrooms, learning resource centers, and libraries.

7. Seventy-three percent of all nursing programs have access to university computer programmers; few have nursing systems analysts. Fifty-three percent of all programs have educational/instructional technologists on their staffs. The larger the program, the more likely it is to have computer support staff.

8. Only four published articles were provided as reference sources by the respondents.

Major problems and issues of introducing computer/electronic data processing technology were identified as:

1. Limited knowledge of and exposure to computer terminology;
2. Need for computer systems staff;
3. Budget/financial/economics of time and money;
4. Access to computer services in the clinical and non-clinical areas;
5. Shared use of computers/time sharing;
6. Time and effort of faculty/faculty release time;
7. Faculty and student attitudes toward computers; and
8. Curriculum planning/revision--present and future.

Although the literature suggests that beginning efforts of application of CAI to nursing have been made, much research and development efforts must be made prior to the widespread acceptance and use of this form of instructional technology. As with any technological advance, the decision to implement CAI should be made in a systematic rather than haphazard manner.

Statement of the Problem

There is a need for a decision-making schema for implementation of CAI into baccalaureate nursing programs. Such a schema should result in maximal learning and teaching effectiveness and efficiency while minimizing the expenditures of available financial and faculty resources.

Statement of the Purpose

The purpose of this study was to construct a decision-making schema for implementation of CAI into baccalaureate nursing programs. Major problems and issues associated with computing which were identified in Elmore's (1974) study as well as others substantiated by related literature were used in the construction of a decision-making schema. The usefulness of the schema was tested by application to a small, private, liberal arts college's nursing program.

Perspective of the Study

Chapter I has presented the introduction, the background of the problem, a statement of the problem, and the purpose of the study.

Chapter II presents a review of the literature. Major topical areas included are (1) the impact of technological advances on education, on teaching and learning, and on nursing practice; (2) features of computer-assisted instruction; (3) some administrative concerns about CAI; (4) decision-making processes applicable for adopting CAI; and (5) processes and issues related to implementing innovative teaching strategies.

Chapter III presents a detailed account of the processes involved in the development of the decision schema.

Chapter IV presents the application of the decision schema to a small private, liberal arts college's department of nursing. The sources of data which were used in the decision-making process were incorporated.

Chapter V provides a summary of the study, conclusions and recommendations.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Chapter I presented the introduction, the background of the problem, a statement of the problem, and the purpose of the study. Chapter II presents literature findings in areas identified as relevant for comprehensive understanding of the purpose of the study. Brief considerations of the impact of technology on education, teaching and learning, and nursing are presented in order to provide clear focus on the larger domain of which computing is one aspect.

A comprehensive review of instructional computing and CAI specifically is presented. An overview of the evolution of CAI, its relation to programmed instruction and individualized instruction, CAI modes, its advantages and limitations, CAI hardware and software issues, its effect on teaching and learning, staffing implications with CAI, and the current applications of CAI in nursing education are considered.

Administrative considerations in implementing instructional innovations such as CAI are presented. Although not intended to provide a thorough review, this chapter also presents key elements to be considered in the decision-making process and presents processes and issues related to implementing innovative teaching strategies.

Technological Advances

Impact on Higher Education

American society has been described as becoming a "technetronic" society, that is, one that is shaped psychologically, culturally, socially, and economically by the impact of technology and electronics (Birckhead, 1975). Obviously, educational approaches have been influenced by this development. deTornyay (1970) suggests that technology, specific to education, exists to bridge the gap between theory and practice. In this regard, an important concept is that technology-generated machines are only tools which should serve as functional parts of systems (Zielstorff, 1978). In that the educational system is an open system, it can be affected by technology as well as having its affect on the technological advances. Koch (1975) suggests that a "true" technology in education is one that will integrate the human and non-human resources into a comprehensive system that will improve learning and provide the highest quality of education.

A report of the Carnegie Commission on Higher Education (1972) regarding educational technology concluded that:

1. Higher education (and education generally) now faces the first great technological revolution in five centuries in the potential impact of the new electronics.

2. New technology has already transformed (a) research techniques in many fields and (b) administrative methods on many campuses. It is now (c) affecting large libraries and (d) is entering into the instructional processes . . . The new technology may provide the single greatest opportunity for academic change on and off campus.

3. The experience thus far with the new technology (applied to instruction), however, as compared

with the hopes of its early supporters, indicates that it is (a) coming along more slowly, (b) costing more money, and (c) adding to rather than replacing older approaches--as the teacher once added to what the family could offer, as writing then added to oral instruction, as the book later added to the handwritten manuscript.

4. Nevertheless, by the year 2000, it now appears that a significant proportion of instruction in higher education on campus may be carried on through informational technology . . .

An interesting stance regarding the relationship between technology and higher education was offered by Rockart and Morton (1975).

> Everyone who discusses "the impact of technology on higher education" has an implicit model of what really goes on in higher education. Most usually, in these discussions, the technology is well described and its "impact" is stated. Yet the implicit model of the process on which the technology is to have "impact" remains unstated. The conclusions, therefore, are hard to pin down--or to refute. The generality of such conclusions provides little guidance for the managers of the educational process who seek operational definitions of ways to impact education through technology in the best ways.
>
> A precise model, by contrast, enables one to describe and partition the possible impact of various technologies on segments of the learning process. Further, and of equal importance, it enables others to test an author's conclusions about the effects of the technology with reference to the stated model. Finally, a reader can test the author's conclusions against his own model of the learning process--and determine whether differences in perspective are based on differing perceptions of learning or differing perceptions of technology. Until each of us involved in the process of education clarifies, or at least states, his own model of the learning process, little viable, constructive discussion of the place of any technology in higher education is possible.

Impact on Teaching and Learning

Advancement of educational technology has stimulated a change in the role of the teacher from conveyor of information to that of learning diagnostician, guider, motivator, and facilitator (deTornyay, 1971; Franzen, 1977). As suggested by Koch (1975), the great teacher may very well become the one "who can create the best learning opportunities to meet each learner's needs and capabilities and then stimulate him in his own way, at his own speed." Similarly in regard to aspects of learning and teaching affected by educational technology, the Carnegie Commission of Higher Education (1972) summarized that:

> 1. The quality of teaching, which varies now depending upon the excellence of the teacher, can be uniformly upgraded by the technology which is now or will be available in the next two decades.
>
> 2. The student will be presented the opportunity, if not the mandate, to self-pace his learning, enriching his experience largely by the challenging material available to him on an individual basis.
>
> 3. Learning will not be lock-step. Far from dehumanizing education, technology will allow the student to adjust his education to his own peculiar profile.
>
> 4. With equipment provided to allow the student to acquire much of his learning experience, the instructor will be freer to carry on individual and small group work with the students, with the time to be an inspiring model who the student will be happy to attempt to follow.
>
> 5. With our society increasingly dependent on the material goods produced by technology, study involving technology will, if properly understood, allow the student to determine in his mind the role of man in this world.

Impact on Nursing Education and Practice

Millsap (1976) has observed that the nursing literature of the early 1970's reflects great dissatisfaction with the methods of instruction traditionally used in nursing education. Student nurses are becoming more critical of the quality of their education and are demanding assistance in the development of skills that will be useful to them after "facts" have been replaced by new knowledge (Valish and Boyd, 1975). In order to meet this demand and to enhance learning, nurse educators must identify all potential teaching-learning strategies available, including those made possible by contemporary technological advances, and select those that will assist the learners to gain information most effectively and efficiently (Poshek, 1976). As suggested by Roueche (1979), we have long since moved beyond the point of justifying strategies utilized by the reasoning that "we have always done it that way."

Technological advances have found their way into nursing education as exemplified by the use of electronic media such as the telephone, radio, television, films and computers. The usefulness of such instructional technology is determined by multiple factors such as learning objectives, availability, and cost to mention only a few. Lack of attention to careful and deliberate planning has led to misuses of existing technologies. Rather than integrating instructional tools into the curriculum, they have often been "tacked-on" and have enjoyed little utility. It is not unusual to find equipment, soft and hardware, stored and collecting dust because monies were expended prior to careful planning. Greater recognition of the need for careful planning and decision-making in regard to instructional technologies is growing and various guidelines have been developed (Kemp, 1977).

As was indicated in Chapter I, one major area of marked technological advancement, computing, has had little application in nursing education to date. Students move into the area of nursing service and find that they are "computer illiterate" in an environment that makes marked use of computing. Broadly, "literacy connotes some minimal level of skill that is appropriate for the circumstances in which the individual must operate" (Hansen, Klassen, Anderson and Johnson, 1979). More specifically, "Computer literacy refers to a knowledge of the non-technical and low-technical aspects of the capabilities and limitations of computers, and of the social, vocational, and educational implications of computers" (Hansen, Klassen, Anderson and Johnson, 1979). Nursing students encounter two major categories of computing in the clinical practice setting: direct patient physiological monitoring devices and hospital information systems which can be utilized to perform complex logical and decision-making skills (Birckhead, 1975). Students are apt to directly use computers in the care of patients, in the transcribing of nursing notes, in generating nursing care plans, and in the dispensing of medication and control of narcotics (Bushor, 1962; Davis, 1968; Rosenberg, Rezinkoff, Stroebel and Erickson, 1967; Scholes and Barber, 1976).

Computer-Assisted Instruction

Overview

Developments in instructional computing began 15 to 20 years ago. Early advocates implied that this technology offered a panacea for all of higher education's problems. Also suggested was the notion that "teaching machines" could replace the teacher in the classroom.

As with other technologies, instructional computing has proven to be a source of enrichment rather than replacement of the teacher or other conventional means of instruction (Rockart and Morton, 1975; Hausmann, 1979).

Three primary uses of instructional computing have evolved: (1) learning with computer support, (2) learning about computers, and (3) use of computers to help manage the instructional processes. Terminology most frequently applied to the first use, learning with computer support, is computer-assisted instruction (CAI) or computer-based instruction (CBI). Definitions of these terms are:

> Computer-assisted instruction: a teaching process directly involving the computer in the presentation of instructional materials in an interactive mode to provide and control the individualized learning environment for each individual student. These interactive modes are usually divided into drill-and-practice, tutorial, simulations and gaming . . . (Splittgerber, 1979).

> Computer-based instruction: the utilization of an automatic teaching system which allows the student to be an active participant in the learning process, by allowing him to determine what data he needs and then allows him, working at his own rate, to search for, organize, analyze and synthesize the data in whatever way he desires. The computer is used for direct instruction and self-discovery (Bitzer, 1966).

Although the definitions found in the literature for each of these terms differ slightly, the terms are commonly used interchangeably. Computer-assisted instruction is the more commonly used term and is used throughout the remainder of this study.

In the second primary use of instructional computing, learning about computers, the student is actively involved in traditional computer science activities, that is, in directly manipulating the functional interface of hardware and software applications. Computer-managed instruction (CMI) is the term most commonly associated with the third primary use of instructional computing. Definition of this term is:

> Computer-managed instruction: an instruction management system utilizing the computer to direct the entire instructional process, including CAI, as well as traditional forms of instruction which do not use the computer. CMI has some or all of the following characteristics:
> 1. Organizing curricula and student data.
> 2. Monitoring student progress.
> 3. Diagnosing, prescribing and evaluating learning outcomes.
> 4. Providing planning information for teachers (Hausmann, 1979).

Of importance is the distinction that the computer serves as a teacher in the CAI or CBI modes and as a manager in the CMI mode.

Computer-assisted instruction can be viewed as a compound resulting primarily from the union of programmed instruction and use of interactive computing systems (Valish and Boyd, 1975). Atkinson and Wilson (1969) suggest that the development of programmed instruction was the most important factor in stimulating the growth of CAI. The interest in programmed instruction during the 1950's, stemming primarily from the work of Skinner, focused the interest of educators on the problem of individualized instruction. As suggested by Buchholz (1979), CAI differs from programmed instruction in its capacity to offer learners a number of options and responses, especially offering branching. This capacity allows for differences in learning speed, enabling the "brighter" student to cover the same content in shorter periods of time and eliminating repetitive content.

Stolurow (1970) has suggested that the concept of CAI is "the integration of inputs from a variety of sources and the attendant processing to make decisions and recommendations about any available instructional resource." The aim of such systems is to "foster the development of student/faculty interactions, to facilitate student development, and make possible a truly individual progress plan while making maximum use of institutional resources." As affirmed by Buchholz (1970), the most significant characteristic of CAI is that it is a highly individualized instructional method.

The concept of individualized instruction is not new, rather, it became the core of an explicit body of doctrine at the end of the 19th century (Suppes, 1966). Modern criticism of individualized instruction has been based upon its seemingly economic inefficiency. The advent of computer-assisted instructional systems may ultimately ameliorate this criticism and make individualization of instruction a pragmatic reality.

As suggested by Feldhausen (1970), CAI is fast becoming better at accomplishing some tasks than any other media. It can:

1. Secure, store and process information about student performance prior to and/or during instruction to determine subsequent activities in the learning situation.

2. Store large amounts of information and make it available to the learner more rapidly than any other medium.

3. Provide programmed control of several media such as slides, television, and equipment.

4. Give the author or teacher an extremely convenient technique for designing and developing a course of instruction.

5. Provide a dynamic interaction between student and instructional program not possible with most media.

Conclusive research findings on the instructional effectiveness of CAI are difficult to find (Rockart and Morton, 1975). Many studies have been implemented concerning the effectiveness of CAI as an approach; however, most fail to give enough detail to the instructional applications to allow generalization to be drawn (Hausmann, 1979). Based upon available research, Splittgerber (1979) states that the following conclusions are generally supported:

1. Generally, CAI has the potential to be an effective instructional aid when measured through the results of student achievement. It appears to be more effective in tutorial and drill modes than in problem solving and simulation and gaming modes. Tutorial and drill modes seem to be more effective for low ability students than for middle or high ability students.

2. When students are permitted to proceed at their own rate, they will generally learn more rapidly through CAI than through traditional instructional methods.

3. The retention rate of materials learned under CAI appears lower than for traditional approaches.

4. CAI, as a supplement to regular classroom instruction, is as effective as other means of individualized supplemental instruction.

5. With notable exception of equipment malfunctions, both students and teachers were highly enthusiastic about CAI as an instructional mode.

6. Longitudinal studies would appear necessary to determine if the expressed enthusiasm is due to the novelty of the CAI mode.

Hausmann (1979) perceives instructional computing to be firmly established in the educational environment of higher education.

As such, he has offered the following conclusions:

1. The computer has become a necessary part of higher education in disciplines where the analysis needed is possible only by using the computer. This is to say, disciplines like sociology, statistics, etc., owe their continued existence to the computer.

2. Using the computer as a teaching tool or aid is not a major use at this point. However, faculty interest in CAI, especially drill and practice, is beginning to grow steadily. As technology advances and provides even better tools for CAI, we will see even larger growth.

3. Many instructors who have been skeptical of CAI as an educational innovation are accepting it now as the computer is proving itself as a viable educational tool as well as a tool for our society in general.

4. The use of computers as an instructional tool is growing in all disciplines of higher education.

5. A significant number of higher educational institutions make little or no use of computers. This is due in most cases to economic limitations.

6. Instructors see lack of instructor training in computer use, lack of equipment, and lack of time to prepare materials as the major roadblocks to greater use of instructional computing.

7. There is little use of commercially published curriculum materials using computers. Most use involving CAI is with locally produced materials.

8. The promises to education by instructional computing are significant enough to warrant serious use of computers especially in tutorial and drill and practice modes.

9. Though little sound research is available, there is a significant amount of information available substantiating the effectiveness of the computer as a learning tool.

The review of literature in the general area of instructional computing and CAI specifically indicates that educators must give serious consideration to this innovation.

CAI Modes

The major categories or modes of CAI in use include: drill and practice, tutorial activities, dialogue, and simulation and game activities. The drill and practice mode is the least complex of all CAI modes. This mode serves as a supplement to the regular curriculum which is taught by the teacher. The introduction of concepts and new materials is handled in the conventional way by the teacher and the computer serves as a mode for practice in application (Collart, 1973; Suppes, 1966; Kuramoto, 1978).

Of greater complexity than the drill and practice mode is the tutorial mode. The aim of this mode is to relieve the teacher of the main responsibility for certain portions of instruction. That is, original material rather than supplemental materials are presented. This mode relies on coaching sequences which direct the student to a discovery of the correct answers; therefore, more sophisticated responses are called for than in the drill and practice mode. The tutorial mode is related in theory to operant conditioning and more than any other mode, exemplifies the automation by computer of the programmed instruction text (Kuramoto, 1978; Collart, 1973; Suppes, 1966).

The most complex mode is that of dialogue activities. In this mode, the student is actively engaged in true "conversation" with the computer. This is the least formally structured mode and does not present textual material as a basis for questioning of the student. Technological advances which would enable the computer to respond to an unlimited range of student input is necessary before major application of this mode is possible.

The mode of simulation and gaming is used when a student has received the basic information about a topic and then must use this information in interaction with the computer in order to gain deeper understanding. Naber (1975) suggests that the essence of simulation consists of:

1. imitation of some aspect of reality;
2. required active participation by the learner;
3. immediate feedback to be utilized in subsequent decisions; and
4. a problem that is modified by the action of the the respondent.

Simulation and games enable the student to explore situations which might be too expensive, dangerous, or time consuming in real life. Of particular relevance to nursing, this mode enables the student to explore ramifications of wrong answers and thereby extend his or her knowledge without endangering or hurting patients (Collart, 1973; Schneiderman and Muller, 1972; Kuramoto, 1978). An important caution in regard to simulation and games is offered by Naber (1975). That is, one should not assume that performance on a computerized case simulation problem can predict how the student will behave in the real life situation; rather, only how she or he is capable of behaving.

Advantages of CAI

The advantages of CAI reported in the literature far surpass reported limitations. Of major importance, the use of CAI helps to shift the emphasis in education from the teacher and teaching to the learner and learning (Buchholz, 1979). By nature of its individualization, CAI can be geared to the specific abilities, achievements, and progress of each student thereby allowing the student to proceed at his or her own rate, using his or her own techniques. The learner can be independent and self-directing. The gains from immediate feedback and reinforcement are also seen as advantages of CAI. Theoretically, the computer is ready to teach at any time, day or night, thereby allowing the student to choose when he or she wishes to learn (Kirchhoff and Holzemer, 1979; Reed, Collart and Ertel, 1972; Buchholz, 1979; deTornyay, 1970; Valish and Boyd, 1975; Bitzer and Boudreaux, 1969; Huckabay, Anderson, Holm and Lee, 1979).

The teacher is freed from many constraints of traditional teaching by CAI, thereby allowing greater time for individual attention to students, advising, scholarly endeavors, and related multiplicity of typical faculty activities. Pragmatically, CAI offers the potential of allowing the nursing faculty member greater time in the clinical area with students by nature of reducing the number of classroom lecture hours and related record keeping activities. This would have the added potential of reducing the faculty /student ratio. Additionally, CAI has the potential to assist the rectification of problems associated with the lack of faculty with particular areas of necessary expertise; in situations of faculty shortage or rapid turnover, CAI can lend stability to the learning environment and curriculum. A further advantage of CAI to both the teacher and learner, is that clinical instructors are not limited for teaching purposes to those patients that happen to be in their assigned areas. By use of simulation, the instructor has the potential of offering the student experiences with any type of patient condition desired (Silva, 1973; Porter, 1978;

Huckabay, Anderson, Holm and Lee, 1979; Kirchhoff and Holzemer, 1979; Buchholz, 1979; Collart, 1973; Bitzer and Boudreaux, 1969; Schneiderman and Muller, 1972).

By nature of its record keeping capabilities on how and what students learn, CAI offers great potential of supporting contributions to theories of teaching and learning as well as greater insight into curriculum development. The utilization of CAI should enhance careful identification and clarification of the truly unique role of the human instructor (Donabedian, 1976; Collart, 1973; Suppes, 1966).

No specific conclusions can be drawn from the literature regarding absolute cost-benefits of CAI. Because vastly differing approaches have been used in computing costs, it appears unreasonable to attempt to generalize from one situation to the other (Rockart and Morton, 1975). Despite the lack of ability to generalize, it is of interest to note that repeated assurances are made that CAI can and will rival traditional modes of instruction in its cost effectiveness. As reflective of this state, Hausmann (1979) states: "Computing is becoming so reasonably inexpensive and so immediately available that the question will be how we can best exploit this new intellectual resource to solve new and more interesting problems."

Limitations of CAI

Limitations of CAI reported in the literature primarily refer to the cost factors involved, lack of standardized hardware and software, the time required for development of programs, and lack of faculty expertise in the area of educational computing. Rockart and Morton

(1975) state that the "most significant forces that influence acceptance and use of any technology are the attitudes and behavior of the people involved." Previously cited references regarding application of CAI have demonstrated a consistently positive attitude in both faculty and students. Johnson (1980) observes that faculty interest in instructional computing is growing; exemplified by a six times greater faculty response to a questionnaire on computing done in 1977 and 1979. Based upon the 1979 data, Johnson summarized the percentages of respondents who indicated the barriers to use of instructional computing as:

Lack of:	Training	55%
	Time	40%
	Equipment	40%
	Interest	32%
	Funds	30%

The data above suggests that the issue of faculty training is far more critical than is stimulation of faculty interest. Johnson states what is obvious from this data: "among those institutions not using the computer today, lack of faculty training is cited as the most important reason."

Another critical variable to consider in regard to staff issues is that the actual development of high quality CAI programs is a very time-consuming process. It has been estimated that approximately 100 hours of program development are required for each hour of actual instructional interaction (Gallagher, 1980). Repeated references suggest that serious consideration should be given to reward systems for faculty who engage in CAI. Specifically, some suggest that faculty should receive publication and/or research credit for the development of CAI programs.

Rapid advances have been made in the hardware available to support CAI. This steady increase in computer technology has resulted in steady decrease in costs of operation (Schneiderman and Muller, 1972). With the advent of the microcomputer in 1977, significant capabilities in education at an affordable cost were further realized (LaFrenz, 1979; Smith, 1979; Gallagher, 1980). Major choices to be made in the hardware area today are primarily those of distributed versus centralized computing, initial computer costs, hardware reliability and support, and the ease of system expansion (Piankian, 1978).

Advances in the development of software to support CAI have not kept pace with hardware development. As stressed by Johnson (1980), "Effective instructional software is increasingly the major factor in using the computer in teaching. To date not much is available." The fact that production of high-quality software is an extremely time consuming and costly venture is well recognized. Johnson (1980) perceives that most efforts are currently being directed toward development of materials for elementary and secondary levels; therefore, software availability will most likely remain a critical issue for higher education. Levien's (1972) observation that it "appears clear that instructional software will become the most expensive component of computer instruction systems as hardware related costs decrease over time" and that "software costs seem likely to be <u>the</u> critical cost factors in instructional computer use in the future" is very well established.

To date, in the area of nursing, there exists no centralized, readily available source or cataloging of available software. The primary source of available educational computer based materials, CONDUIT, does not include the area of nursing.

Effects of CAI on Learning and Teaching

The behaviorist views of Skinner have served as the basic foundation for programmed learning and CAI. The essential elements of this school of thought are that "the learner must be given the opportunity to practice the correct response, must be given knowledge of results through feedback (preferably by reinforcement of the right answer and with a minimum of delay), and must progress by means of successive small steps with hints so that answers would always be right" (Franzen, 1977). The capability of CAI to provide immediate feedback and reinforcement to the student regarding his or her performance are seen to be the greatest factors to consider in the effects of CAI on learning. The provision of immediate feedback and reinforcement provide for learner motivation, thereby making the learner an active participant in the learning process (Buchholz, 1979). Only one study reporting the application of CAI to nursing offered substantial data regarding the impact of CAI on cognitive, affective, and transfer of learning consequences (Huckabay, Anderson, Holm and Lee, 1979). Bitzer and Boudreaux (1969) have suggested that application of CAI can reduce the time required for student nurse learning. Obviously, a great amount of research needs to be conducted in this area.

As has been alluded to previously, the effects of CAI on teachers and teaching are varied. Pragmatically, CAI can be viewed as a timesaving device for the teacher by freeing the teacher of repetitive presentations and record keeping. More significantly, CAI introduces a role change for the teacher. No longer the sole dispenser of information, the teacher now becomes the coordinator of learning experiences and facilitator for the student's learning.

The record keeping function of CAI affords a rich source of information not only on students' performance, but also of the teacher's and/or curriculum's effectiveness. Two effects of using CAI can be the increased effectiveness of teacher performance and the revision or solidification of the curricular structure. The process entailed in CAI program development requires precise delineation of objectives, content and evaluation. This process obviously can effect teachers by requiring them to specify detail that frequently is unstated.

Layton (1969) has reported the following attitudes and actions of nursing instructors as those that students identified as being helpful: being interested in and accepting the student; giving encouragement and praise; willingness to answer questions and explain things; giving responsibility when the student is ready for it; and informing the student of her progress. Silva (1973) has applied these characteristics to the computer in the following manner:

1. computers have basic information about each student;
2. they are infinitely patient teachers;
3. they respect the student's privacy and confidences;
4. they pace the learning at her own speed and give her encouragement and praise when appropriate;
5. they inform her of her progress; and
6. they treat all students in a similar manner and are consistent in their approach.

Silva (1973) views the computer very much as the teacher's ally. In considering the effects of CAI on the teacher and teaching, Stolurow (1970) suggests that an appropriate question to consider is:

> What types of relationships might be developed between computing systems and an instructor so as to amplify the contribution of each and magnify the total contribution made to the instruction received by the student?

CAI Applications in Nursing

Twelve reported applications of CAI in nursing were found in the literature. A brief description of each application follows.

Collart (1973) described the construction and use of a CAI program, "Bottle", on closed drainage systems of the chest which was integrated into a surgical nursing course for junior students at Ohio State University. The program consisted of six modules of which students were required to complete only the first three prior to a two-hour lecture on the physiology of respiration and stressors of patients with decreased oxygenation. Faculty and student responses to the program were affirmative.

Donabedian (1976) reported the use of CAI to teach epidemiology to student nurses at the School of Nursing, University of Michigan, Ann Arbor. The program was structured upon a description of an outbreak of food poisoning followed by a series of questions about the outbreak which were designed to stimulate interest in epidemiology and to develop understanding of basic epidemiologic principles and tools. In addition, facts about food-borne epidemics were included. It was intended that the experience would enhance intellectual skills in problem solving. Student evaluations were highly favorable in regard to the use of the program.

Bitzer (1966) reported on the earliest research based application of CAI in nursing found in the literature. A portion of a medical-surgical nursing study unit was programmed for use on the Programmed Logic for Automated Teaching Operations (PLATO) system. This program was presented to an experimental group of six students and a control group of seven students at the Mercy Hospital School of Nursing, Urbana, Illinois. Post-test results suggested a difference in favor of the PLATO group in terms of learning achieved. Data regarding cognitive style was also considered although no conclusions were drawn.

Bitzer and Boudreaux (1969) reported another study based upon a PLATO program in maternity nursing also conducted at the Mercy Hospital School of Nursing. One class of students was divided into groups matched according to ability. A pre-test-post-test design was used. Findings revealed that post-test scores indicated a significant gain by all students, and a comparison of final examination grades of the control and experimental groups did not indicate a significant difference. A key finding in this study was that the PLATO students learned the same amount of materials in from one-third to one-half of the time required by the control group.

Naber (1975) has also reported use of the PLATO system in teaching nurse midwifery management at the University of Illinois College of Nursing at the Medical Center. Although positive about the use of CAI, the author offered little detail in regard to the application or its evaluation.

Kirchhoff and Holzemer (1979) reported on an application of a PLATO program on postoperative nursing care. This program was used with junior student nurses in a medical-surgical nursing course also at the University of Illinois College of Nursing at the Medical Center. Findings from the study suggest that students did learn from the program; that different learning styles did not penalize a student's learning; and that students' learning was significantly related to the degree to which they found learning on PLATO not to be dull.

Kamp and Burnside (1974) reported their efforts to introduce CAI into a graduate psychiatric nursing class at the University of California, San Francisco. The authors reported positive results which were further affirmed by a student's evaluation (Farnsworth, 1974).

Huckabay, Anderson, Holm and Lee (1979) reported a well-constructed and implemented study which investigated the effect of CAI versus lecture-discussion method of teaching on cognitive learning, transfer of learning, and affective behaviors of nurses. Findings suggested no significant differences between experimental and control groups in cognitive learning, transfer of learning, or affective behaviors, however, significant differences between the groups in three post-test scores on cognitive learning and transfer of learning did exist.

Newman and O'Brien (1978) described the use of computer research simulations used for master's students at New York University. The Michigan Experimental Simulation Supervisor (MESS) was used. This system enabled students to design and run experiments on a variety of data generating models. The simulations enabled students to progress from simple to increasingly complex research designs.

Valish and Boyd (1975) reported a study of the utilization of CAI in the area of continuing education for nurses at George Washington University Medical Center. The purpose of the study was to determine if CAI programs would provide a resource by which registered nurses (R.N.'s) could verify and augment prior clinical knowledge in nursing. Three programs developed at Ohio State University were utilized: Septic Shock, Care of and Feeding by Veins, and Leadership and Management. The findings suggest that the CAI programs did verify but did not augment the nurses' knowledge.

Hoffer, Mathewson, Loughrey and Barnett (1976) reported on a controlled trial of a CAI program on cardiopulmonary resuscitation for R.N.'s at the Cape Cod Hospital. Results indicate that nurses exposed to the CAI program increased their test scores while nurses in the control did not. A related study (Hoffer and Barnett, 1976) reported on a study using the same cardiopulmonary resuscitation program with emergency care physicians. Favorable overall ratings in support of CAI also resulted from this study.

Ronald (1979) has reported the development of an elective senior course at State University of New York at Buffalo School of Nursing, "Implications of Computer Technology for Nursing." The course was designed to familiarize undergraduate student nurses with the capabilities and potential impact of computers on the health care system, the client, and health care professionals. A section of the course provided CAI programs, and students were assigned to complete one CAI package. Student responses were reported as favorable.

Although the literature suggests that beginning efforts of application of CAI to nursing have been made; much research and development efforts are indicated prior to the widespread acceptance and application of this form of instructional technology. Of the reported uses of CAI in nursing, none made mention of program-wide application; rather, each reported CAI utilization with a course or a unit or module within a course. The implications for the need of research in the area of program-wide application are obvious.

Administrative Educational Leadership in Innovation

Decision-Making

"Giving educational leadership to the collegiate nursing program is the most vital function of the administrator" (Gallagher, 1965). Leadership is a necessary qualification of the nurse administrator, and in turn, a facility for decision-making is one of the attributes of a successful leader (Beyers and Phillips, 1971). Shanks and Kennedy (1970) state, "The ability to make decisions has become a prime requisite for success in administration."

> Decision making is a process involving the reduction of multiple alternatives down to one alternative that is judged as best. But as institutions grow larger, the decision making process becomes more formalized and complex. In academic institutions this process is often handicapped by cumbersome bureaucracies, poor channels of communication, and lack of participation by faculty. While most educators agree that progress depends on sound decision making, controversies continue over who should make decisions and how decisions should be made (NLN *Decision Making Within the Academic Environment*, 1978).

The complexities of the decision-making process would appear to mandate a broad knowledge base and formal preparation as a prerequisite for the professional performance of administrators. Shotzberger (1972) suggests that this is not the case and that administrators in higher education have four common characteristics:

1. their positions require knowledge and skills with which few were originally endowed;
2. all of them are required to manage;
3. many of them move into college administration because they have been effective performers in other areas which brought to light their accomplishments, rather than having been trained, educated, or prepared to fill the academic position; and
4. most are left to learn the job by doing it.

In addition to the limitation of formalized preparation for their role, educational administrators are facing what appears to be a paradox; in a time when administrative decisions are being increasingly scrutinized, there exists a reduction in administrator "authority". Rapidly developing faculty and student roles in governance have required a reduction in administrative autocracy and/or authority. In response, administrator style of management is now moving from a position of authority to one of professional colleagueship. Nevertheless, the administrator still assumes final responsibility for the consequences of decisions made.

In order to enhance optimal leadership and decision-making, Shotzberger (1972) suggests that administrators:

1. know what administration or management involves,
2. become keenly aware of and knowledgeable about decision theory and its applications,
3. develop an awareness of systems analysis, and
4. develop an understanding and knowledge of communications theory and its application, and

5. develop a knowledge framework of human relations.

Fordyce (1978) has organized factors affecting decision-making within the academic environment into four categories: institutional, personnel, personal and economic. Concerns regarding the mission of the institution, its tradition, and its planning and goal setting are classified as institutional factors. Aspects of change, planning for, implementation of, and consequences of, in addition to issues of governance and collective bargaining are considered in the category of personnel. Personal factors address administrative style, personality and decision-making processes used by the administrator. Finally, the economic factor considers all issues that relate to the budgetary process.

Kelley (1978) reported that decision-making in schools of nursing occurs at three distinct planes: the technical or instructional level, the managerial or institutional level, and the community or societal level. Each plane is interdependent on the others and may be affected by decisions made at other levels. Kelley further suggests the following typology of decisions which may occur in academic nursing:

1. <u>Decision making for the purpose of operationalizing school of nursing or program goals.</u> This type of decision involves assessment of the means and resources necessary for achievement of end goals.
2. <u>Decision making for planning of an on-going program</u>. This type of selecting between alternatives is diagnostic in nature and looks for discrepancies between intended and actual program goals, objectives, needs and impact.
3. <u>Decision making for carrying out a program</u>. This type of reducing alternatives involves day-to-day decision making based on monitoring program operations and obtaining accurate feedback.
4. <u>Decision making for quality control</u>. This type of passing judgement is concerned with determining the extent to which program goals were reached.

> It involves evaluation of a program and deciding whether or not to maintain, modify or to end the program. Evaluation of nursing education programs helps substantiate their effectiveness and efficiency in meeting society's needs.

In regard to the decision-making process, Kelley (1978) offered the following observations:

1. Decision making is a cycle of activities involving identification of a problem, search for and selection of a predictable alternative, authorization and implementation of a decision, and evaluation of the decision.
2. Decisions are guides to action after they have been interpreted in the form of new programs or modification of existing ones.
3. Sound decision making depends upon the extent to which choices are communicated to those involved in and affected by its implementation.
4. Decisions need to be revised as a change in emphasis in goals occurs. Decision making in a health care setting takes on a cyclic, rotary character in that a multitude of goals are in existence; certain goals are stressed at one time and others another time.
5. A variety of decision making tools is available to academic nursing to make the process more effective and less painful, but they are rarely utilized.

Shotzberger (1972) noted that there is a distinction between decision-making and the decision-making process. " . . . a decision involves arriving at a choice from among an array of alternatives or possibilities." The decision-making process denotes the activities that have been employed to reach the decision. The function of decisions is to cause a response within an organization or system. Decisions are made under conditions of certainty, uncertainty and risk. The condition of certainty suggests that the outcome is almost assured; the condition of risk infers a large number of decisions and interactions that make it difficult to predict outcome. The condition of uncertainty "exists when the decision maker does not have accurate knowledge of future relevant events and of the ultimate outcome of possible decisions" (Daniel and Terrell, 1978).

It is in the conditions of uncertainty and risk that decision theory or decision analysis has its greatest utility. Originated in 1950 by Abraham Wald, modern decision theory has been further refined by Raiffa and Schlaifer (Daniel and Terrell, 1978). Decision analysis has been defined as "a technology that assists individuals and organizationsto make up their minds, by quantifying the considerations, however subjective, which enter into any decision" (Brown, 1974).

Daniel and Terrell (1978) state that there are three essential components to a decision-making problem:

1. Alternative acts. If only one course of action can be pursued in a given situation, no decision making problem exists. In order for a decision process to operate, the decision maker must be required to choose from at least two alternative courses of action, or acts.
2. Possible states of nature. These are the circumstances prevailing when a decision is implemented, that have an effect on the payoff of the decision. The difficulty in decision making stems from the fact that the decision maker usually does not know which of the possible states of nature is the true one.
3. Payoff. Associated with each act is a payoff, or result of the particular action taken. In the business world, payoffs are usually of a monetary nature. However, in most nonbusiness decision making, payoffs cannot be expressed in dollars and cents. In clinical medicine, for example, the payoff for an act may range from mere inconveniences through various degrees of pain and incapacitation to death. In these situations, the value of a payoff is expressed in terms of utility.

In order to use decision analysis, the value of each payoff or utility must be expressed in a common unit of measurement. Decision-making, whether of large or small proportions, will typically follow the same schema: clarification of the problem, finding creative alternatives, weighing alternatives, making the choice among alternatives, and evaluating the outcomes (DuBrin, 1974; Marriner, 1977; Claus and Bailey, 1979). DuBrin (1974) offers the following categories of decision characteristics:

> Superoptimum: refers to those unique, breakthrough, entrepreneurial type decisions that provide an organization with a new thrust.
> Optimum: are those that lead to most favorable outcomes.
> Satisficing: are those that meet with a minimum standard of satisfaction, they are adequate, acceptable, passable and "OK".
> Suboptimum: are those that lead to undesirable outcomes. Their consequences are dysfunctional to the system.

Bailey and Claus (1975) add an additional category, defensible decisions, to those cited by DuBrin. "A defensible decision is one that can be explained and whose every step can be recalled if necessary. Defensible decisions are critical when large expenditures of financial resources are required or when an untoward outcome is irreversible."

A variety of decision-making tools which summarize and organize components of the decision problem are available. "Use of such tools would set forth possible alternatives and their consequences in a logical fashion, so that faculty, students, administration, and critics could understand how and why the final decision was made" (Kelley, 1978).

One decision tool, the payoff table, uses the three essential components of a decision problem, alternative acts, possible states of nature, and payoff to develop a decision grid and assigns probabilities. Another tool, the decision tree, also uses the three essential components in a graphic display of the problem. Because of its ability to clearly depict the paths by which the various available outcomes can be reached, the decision tree is preferred in many situations (Daniel and Terrell, 1978). "The decision tree is composed of a series of nodes and branches. The branches represent alternative courses of action, and the nodes represent chance events which, in turn, generate additional alternatives. At the end of each terminal branch one finds the payoff associated with the sequence of acts leading to it" (Daniel and Terrell, 1978).

Systems analysis and modeling are also possible tools for decision making. Bailey and Claus (1975) define a system as "something which is made up of a number of separate parts or elements; the parts or elements of the system rely on each other, are interrelated, have a common purpose, and together form a collective entity or wholeness. Effective systems are characterized by being efficient, reliable, repeatable, and purposeful." Because systems can be subdivided into subsystems and then further into sub-subsystems, components, elements, units, or parts, systems analysis is especially suited to study complex problems or situations (Finch, 1969; Hazzard, 1971). Breaking the "whole" into "parts" allows for the study and manipulation of relationships.

Systems can be classified as open or closed, the essential difference being whether exchange of matter or energy occurs with the environment. In this definition, environment refers to "the set of all objects, a change in whose attributes affects the system, and also of those objects whose attributes are changed by the behavior of the system" (McMillan and Gonzales, 1965).

A cybernetic system is characterized by the use of feedback to control behavior. Four major process elements of such a system are: "(1) the inputs; (2) the throughouts or transformation processes; (3) the outputs; and (4) the feedback or knowledge of results" (Bailey and Claus, 1975). Decisions may be corrected, supplemented, or modified based upon the feedback mechanism of this system.

Systems analysis allows for hypotheses to be generated regarding system behavior. Model building is an extension and formalization of hypotheses.

> As an abstraction, simplification, or idealization of the system or event, the model helps to describe or in some sense duplicate it. Models cannot replace the real world; at best they can reduce a complex system to manageable proportions or serve to crystalize our thinking and perception. Models are neither true or false, their value is judged by the contribution they make to our understanding of the systems they represent (McMillan and Gonzales, 1965).

Models may be roughly classified according to their complexity: descriptive models attempt to explain events occurring in the system; analytical models attempt to explore alternatives that provide a logical basis for decision-making; and mathematical models use probability theory in an effort to predict future outcome (Finch, 1969).

Regardless of the decision analysis tool selected for use, the ultimate objective is to make a wiser decision. Daniel and Terrell (1978) note:

> In attempting to apply decision analysis, decision makers are forced to think about the problem under consideration in a systematic and thorough manner. Such scrutiny of the situation will help the decision maker better understand the individual elements of the decision-making process as well as the manner in which the pieces fit together to form a coherent

> and integrated process. This type of understanding cannot help but improve and enhance the judgement of the decision maker.

Administrative Role in Innovation

Dudgeon (1976) states that many programs lack innovative instructional activities because the administrator is unclear of his/her role in innovation or the climate necessary for innovation to occur. He observes that there are three major job activities for the administrator in innovation: determination of goals, provision of the means, and evaluation of the results. In terms of setting goals, Dudgeon offers the following suggestions:

1. Plan educational change.
2. Discourage change for the sake of change and attempt change that leads to greater specificity of objectives and better learning outcomes.
3. Choose a planning methodology which permits the solving of complex educational problems and provides for quantification.
4. Use a systems approach--analysis, synthesis, modeling and simulation.
5. Use an eclectic approach, since no one has the perfect all-encompassing method or educational panacea.
6. Educate college board members and senior administrators to the necessity of: (a) placing the learner at the center of all activity; (b) achieving better learning outcomes; and (c) supporting innovative practices.
7. Instructional objectives should lead to management objectives.
8. The managers and the management process must support the instructional process.
9. A computer-assisted management information system will be used to assist the program management.

Kemp (1977) suggests that administrators begin goal setting activities by identifying reasons why it is important to make changes in the educational program. These reasons, in turn, will reveal needs that are existent within the program. After needs have been identified, basic elements that must be considered in innovative activities are planned and considered in order that learning can take place most effectively and efficiently and that measurement criteria can be applied during evaluation.

In the area of means provision, Dudgeon (1976) suggests that the most important is that of environment or climate. Administrators must have the freedom necessary for innovation, dissemination, implementation and utilization to occur. The following are examples of typical means identified by Dudgeon:

1. Support administrators who are attempting innovative instructional design and delivery.
2. Define a competent administrator in terms of "innovativeness" as well as traditional managerial competencies.
3. Send administrators to seminars and conferences where they can interact first-hand with innovators and implementors. Invite successful innovators and educational entrepreneurs to your campus.
4. Provide for an above average amount of professional development for personnel.
5. Administrators should become students of the communication of education innovation.
6. One of the most important means is money. Therefore, administrators should set priorities on the spending of money to meet the objectives they have set for innovative instructional goals. Every possible financial trade-off must be investigated if it has an implication in or for the innovative process.
7. It is important to amortize the costs of innovative designs in a manner similar to industry models.
8. While people in the organization work toward the implementation and management of individualized and personalized education programs, they often discover many weak areas of the operation. These should be opportunities for rejoicing, correction and improvement rather than opportunities to penalize people.
9. "Means" implies that we have trained people.
10. Training in innovative processes must be appropriate to the persons being trained.

11. Providing the means involves a check of the hardware and a guarantee by administrators to provide necessary equipment and software. The best innovations will fail if we do not provide the hardware and software support.

Evaluation activities may be categorized as: measurements of learning, program costs, and determinations of attitudes (Kemp, 1977). These measurements will indicate both the quantity and quality of outcomes. Measurement of learning can be approached by establishment of a program's effectiveness and efficiency. Effectiveness is established by the percentage of students who reach an acceptable level of achievement for each objective. "The measurement of the ratio of the number of objectives a student achieves to the time the student takes to achieve them is a measure of the program's efficiency" (Kemp, 1977). Kemp suggests that the following factors be considered in regard to program costs:

Planning and Initial Development

1. Planning time (percentage of salary for time spent by each member of the planning team on the project, or number of hours spent by each member multiplied by his or her hourly salary rate, and fees for consultants)
2. Staff time (percentage of salary for time spent by each member engaged in planning and production and in gathering materials, or the number of hours spent by each person multiplied by his or her hourly salary rate)
3. Supplies and materials
4. Outside services for preparing or purchasing materials
5. Construction or renovation of facilities
6. Equipment
7. Installation of equipment
8. Testing, evaluation, redesign, reproduction, and so on of resources (including personnel time and costs of materials and services)
9. In-service education for teachers, aides, and others who will participate in the program during implementation (cost for time)

10. Overhead (utilities, furniture, room or building costs or depreciation allowance)
11. Miscellaneous (office supplies, telephone, travel and other items)

<u>Operating the Course (Per semester or quarter)</u>

1. Administrative salaries (based on percentage of time chargeable to the project)
2. Faculty salaries for the time spent in the program working with groups and individual students, planning daily activities, evaluating program, revising activities and materials
3. Salaries for aides, maintenance technicians, and others
4. Replacement of consumable and damaged materials
5. Repair of damaged equipment
6. Depreciation of equipment
7. Overhead for utilities, facilities, furnishings, custodial services
8. Evaluating and updating materials (personnel time and materials)

The factors outlined above will allow for computation of cost effectiveness, instructional cost index, and ongoing operational cost index.

In the final phase of evaluation, assessment of attitudes of students and faculty must be considered. "Student opinions and attitudes provide not only indications of important non-measurable outcomes, but also give useful feedback for improving a new program" (Kemp, 1977). Faculty attitudes are important to assess in that they undergo role change during innovation; therefore, attitudes may also change.

Although evaluation of innovations is complex and specific to each situation, Diamond (1975) has given the following list of indicators of improved instructional effectiveness.

<u>The Student</u>

1. Improved Learning--Same Cost
2. Equal Learning--Less Cost
3. Reduced Dropout (Failure) Rate
4. Improvement in Attitude (toward subject/education/institution/society)

5. Reductions in Time Requirement
6. Increase in Credits Generated (options/content)
7. Increased Retention of Brighter Students (reduction in transfers)

The Faculty

1. Increase in Faculty/Student Ratio (reduction of teacher cost per student)
2. Decrease in Time Requirement
3. Increased Specialization and Subject Offerings
4. Increased Direct Student Contact (at no increase in cost)
5. Improvement in Faculty Attitude (toward student, course, department, institution)

Instructional Space

1. Decrease in Total Requirements
2. Increased Student Capacity

Instructional Resources

1. Increase in Total Resource Utilization (resource use increase)
2. Increase in Efficiency of Use (units reach more students)

The Community

1. Improved Attitudes Toward Institution
2. Increased Number of Community Needs Being Met

In addition to the preceding recommendations regarding educational innovations, Fordyce (1978) stresses that an administrator contemplating initiation of change in a program must carefully consider the following factors:

1. Finance. In what manner will the change be financed? Have any anticipated budget increases been discussed with the understanding that the change and cost is to be long range? If federal funds are being used, what plans have been made to phase out the federal share?
2. Personnel. Does your college have personnel who are fully qualified to implement the change(s)? Has your recruiting been predicated on selection of persons with knowledge of and sympathy for the anticipated changes?

3. Students. Have your students been fully informed as to what the program will entail? Will any analysis of student reaction account for the "Hawthorne Effect?" Will any data be collected on student achievement for further research and analysis? How will the change affect other programs?
4. Facilities. Can the proposed changes be accommodated in the present facility? Will renovations be needed? Can the renovations be financed? Can the renovations be made without disruption of the on-going program?
5. Constituency . Does the proposed change impact on your professional or lay constituency? Are they aware of it? Have they participated or been consulted in development of the proposed change? Has an implementation strategy been developed?

Obviously, many interactional factors must enter into the decision-making process regarding innovation and/or change. Decisions are not made in isolation; one decision may link with previously made decisions or generate the need to make additional decisions.

Summary

Areas considered in the Review of the Literature support the timeliness of considering implementation of CAI into nursing education. Perspective has been gained in terms of the modes, advantages, limitations and related issues to be considered in using CAI. Helpful information has been gained in regard to the decision-making process and the administrator's role in instructional innovations. These perspectives and information will form the basis for schema development to be presented in Chapter III.

CHAPTER III

DEVELOPMENT OF THE SCHEMA

Data discussed in Chapters I and II have established the timeliness and importance of the applications of CAI in nursing education. Because academic computing and CAI in particular are new technologies, many nurse administrators may be faced with the need to make reasoned decisions yet not know the questions which should be addressed prior to achieving a defensible decision, one as described by Bailey and Claus (1975) that can be explained and each step reconstructed if necessary. This form of a decision becomes critical when large expenditures of resources are required and when accountability is expected.

Because start-up costs of CAI may be expensive, it appears necessary to develop a decision model or schema to guide the administrator. The purpose of Chapter III is to develop such a decision schema to guide the administrator toward matters which should be considered in making decisions to enter CAI. Obviously, the schema cannot aspire to be all encompassing of all environments and situations, but can potentially serve as a stimulus to guide the decision process in individual programs.

Process of Schema Development

The approach taken to the development of the decision schema was essentially eclectic, based upon findings of the review of the literature as well as the author's personal experiences from nine years as administrator of a baccalaureate nursing program. Although it was originally envisioned that the model or schema would be a cybernetic decision model, it became evident that such a structure was too complex and unwieldy to be functional. As an alternative approach, six major categories of decisions to be made were identified: administration, finance, faculty members, students, facilities, and equipment. Essential elements within each category were specified, and associated "ideal state" statements were developed. These statements contained requisites for program start-up. The identification of the categories, elements and ideal states led to the application of a form of force field analysis. Developed by Lewin, this approach allows for determination of the relative strength of capabilities or constraints to planned change (Lewin, 1951). Knowledge of elements which are assisting or restraining change offers guidance to the administrator of means to enhance capabilities and minimize constraints. The decision schema format is presented in Appendix A, page 86.

Administration

The initial decision category to be considered was administration. Within this category, the first elements to be addressed were the mission and goals of the institution. The author's value judgement was that any program development and/or change must be consistent with the overall mission and goals of the parent institution. Ideal states identified in relation to institutional mission and goals were:

1. Recognition of a rapidly changing world and of innovative technologies and their influence on education.

2. Support for creative, innovative and effective teaching efforts.

3. Commitment for rewarding faculty members who strive to accomplish innovative and effective teaching.

4. Commitment for the individualized professional growth of faculty members as evidenced by resource allocation for such activities.

5. Commitment to use faculty members to their fullest potential in areas of competency.

6. Consideration of individual differences in shaping the academic programs and in creating a climate which encourages students to assume increasingly greater responsibility for their individual learning experiences.

7. Commitment for producing exemplary graduates.

The second element identified within the category of administration was that of the institution's attitude toward long-range planning. This aspect is of importance not only to the start-up aspect of CAI, but also is essential to the ongoing development and implementation of a CAI program. The long-range planning ideal states were listed as:

1. Support for increasing resources (funds, facilities, staff) for technologic advances in education.

2. Commitment to careful coordination among departments to maximize the potential use of resources.

3. Commitment to active participation of departmental chairpersons in decision-making and in allocation of resources.

The final element identified within the administration category was that of the institutional environment. The ideal states for this element were:

1. Commitment to open and full communication between administrators and chairpersons.

2. Support for innovation and change in the educational process.

It is obvious that without positive support and commitment by general administrators, the nurse administrator cannot proceed further in the decision process regarding implementation of CAI. If implementation of CAI is perceived by college/university administrators as running counter to the stated mission and goals and/or the long-range planning objectives of the institution, the probabilities of successful implementation are highly unlikely. In addition, if the environment is not conducive to or supportive of innovation and change, the potential for creating internal stress and tension is great.

Finance

The category of finance is specifically concerned with resources necessary for program start-up. The first element is that of available, adequate funding for initial start-up. Resources should be available within the institution to support the initial efforts. If not, means for obtaining external funding should be readily available. The next element to consider would be the availability of funds for program continuance. A structured plan to phase from external to internal funding should be in place and feasible.

Faculty Members

Elements identified within this category were:

1. Supportive attitudes toward change and innovation.
2. Current proficiency for implementing a CAI system.
3. Trainability and openness to training.
4. Established structure and resources for inservice training.
5. Available usable time in existing workloads.
6. The reward systems.
7. Availability of consultants and resources.
8. The environment.

The ideal state associated with the element of attitude is that faculty members will be supportive of change and innovation. The literature forcefully indicates that high tolerance for change is essential for successful implementation of any innovation. In addition, current faculty members must either be currently proficient in CAI application so that implementation is possible or they must be readily trainable to a level of proficiency. In either case, there must also be already established resources and a structure which makes inservice training available. The presence of faculty competence and the availability of inservice practices are critically important as is evidenced by the reported status of academic computing in higher education (Johnson, 1980).

The elements of time and workload must be considered. Time should be available for inservice training without overload and/or threat to the quality of the existing programs. Time should also be available for development of software and implementation without overload and/or threat to the existing programs. Reward systems for faculty members are also important, for development of software to support the program should receive publication and/or research credit.

Consultants and resources must be considered as necessary elements in support of the evolving program. The ideal state would provide a computer expert, readily available, accessible, and in possession of the appropriate language expertise.

A final essential element to be considered within this category is environment. The ideal state would be to have an interactive and supportive faculty to support development efforts and to maintain the functioning and quality of the existing programs.

Students

Student characteristics such as age, sex, academic backgrounds, and various learning styles must be considered. The ideal states associated with this category were:

1. Maximum individualization of instruction.
2. Sufficient student maturity and accountability to effectively use the CAI approach.

The literature demonstrates that the current student pool for nursing education is highly heterogeneous and that some form of individualized instruction is indicated to maximize each student's potential.

Facilities

In a time of typically crowded academic space and limited resources, facilities become a critical factor to consider. The first element to address is whether space is currently available and adequate to support the needs of CAI. Space should be present and renovation or construction should not have to be considered. However, if construction or renovation is necessary, the ideal state has enabling resources currently in place. In addition renovation or construction should be accomplished without disruption of existing programs.

Availability of the facilities to the student also must be provided. Ideally, the student should have maximum access to the facility. This availability would enhance the student's ability to learn at his or her own speed and at the times he or she chooses.

Equipment

The first consideration related to hardware is that of available consultant expertise. Ideally, expertise would be available within the institution to guide decisions regarding appropriate hardware options. If such expertise is not available, appropriate consultation should be available and obtainable from external sources. Such expertise would be helpful in guarding against investment in limited or inappropriate systems and equipment.

The next element to be considered in this category is the availability of appropriate hardware. Ideally, the hardware would currently be in place and be compatible with the dynamics of CAI. If equipment is not in place, it should be obtained with existing institutional resources or obtained from external funding.

Installation of equipment should be done without disruption of existing programs and provide for assurances of an initially functional system. A responsive service contract should be functioning, for such service should decrease the potential of extended periods of equipment failure which could cause major problems of discouragement and frustration for faculty and students alike.

Finally, system expansion capability should be provided so that modifications and extensions may be achieved easily and with minimal additional resources. The expansion should be accomplished without disruption of the program in place.

The element of software availability must be given careful attention. "The term software encompasses all of the instruction that the computer follows, or executes" (Bowie, 1980). Ideally, software would be available and obtainable to support the program. If not, resources should be available to support the development of software by current personnel. This is an especially critical factor for nursing and was discussed at length in Chapter II.

Procedure for Schema Application

A Likert-type rating scale was juxtaposed between the category/elements and "ideal" statements derived from the decision schema. The purpose of this rating scale was to allow the administrator to identify the relative strength of constraints and capabilities for each category and elements within her/his institution as compared to the "ideal state". The area surrounding the number three on the rating scale was created as the demarcation line between positive (4 to 5) and negative (1 to 2) forces (see Appendix A page 86).

The nurse administrator would consider first the category of administration. She/he would consider each element and its related ideal statement(s). A subjective and/or objective assessment would be made along the Likert scale in terms of the perceived constraints and/or capabilities within the administrator's institution. By plotting the comparative strengths of the constraints and capabilities, the administrator should develop a sharper perspective of the realities of the decision state. This perspective should enable the administrator to develop a concise descriptive statement of reality for each category. Based upon the descriptive statement, the administrator could identify and list available options to convert constraints into capabilities and/or strengthen existing capabilities.

If a positive assessment is made for the category of administration, the nurse administrator moves through each of the successive categories using the same procedure. If a negative assessment is made at the administration category, the nurse administrator is unable to proceed further into the decision schema.

After completing the processes entailed in the decision schema, the nurse administrator should have clear focus of the existing constraints and capabilities of her/his institution in regard to implementing CAI. In addition, to enhance the potential for successful implementation of the program, the nurse administrator must strive for clear, unbiased perspective of the available options. Importantly, the nurse administrator should have generated the basis for a defensible decision.

Summary

Chapter III has presented the processes involved in the development of the decision schema and the procedure for its application. Chapter IV will present an application of the decision schema to a small, private, liberal arts college's department of nursing.

CHAPTER IV

THE PROCEDURE

The processes involved in the development of a decision schema regarding implementation of CAI were presented in Chapter III. The purpose of Chapter IV is to demonstrate the application of this decision schema to a small, private, liberal arts college's department of Nursing. The final product of the schema application is presented in Appendix B, pages 92--97.

Application of the Decision Schema

Administration

The mission and goals of the institution were the first elements to be assessed in this category. Careful review of the published statements of the mission and goals of the college demonstrated that each ideal statement was incorporated. Obviously, dissonance often exists between statements of mission and goals and reality; therefore, the author sought tangible areas of evidence that would specifically support the actualization of the mission and goals.

In regard to the first ideal state, "Recognition of a rapidly changing world and of innovative technologies and their influence on education," the author assessed two factors. Under the leadership of the president and the academic dean, the college was participating in a project specifically designed to define and enhance computer literacy for all students. This project, Quality Undergraduate Education (QUE), was being developed under the auspices of the Council for the Advancement of Small Colleges (CASC) and funded by the Kellogg Foundation. The president and academic dean have each verbally revealed a high level of awareness and a commitment for introducing innovative technologies into the educational system. Based upon these findings, the relationship between the existent and ideal state was rated as five (see Figure 1, page 58).

Evidence to support achievement of the second ideal state, "Support for creative, innovative, and effective teaching efforts," was also found. The college has a faculty member who serves in the role of faculty instructional aide. This capable individual is readily available to all faculty and demonstrates a high level of concern for enhancing the effectiveness of teaching. Advanced training in the area of faculty development has prepared this individual for his role in this area. In addition, the college has a policy that actively enhances deliberate planning for faculty growth. Each faculty member must have a one-to-five-year professional growth plan on file. This plan is intended to assist the faculty member to assess carefully his/her areas of strengths and weaknesses and to plan means of enhancing the areas of strength and alleviating the areas of weakness. An element of each plan is the identification of resources which would be needed for the faculty member to achieve his/her goals. Communication of these needs to administrators allows them carefully and deliberately to plan supportive resource allocation. Based upon these findings, the author rated the relationship between the existent and ideal state as five (see Figure 1, page 58).

Supportive evidence for the third ideal state, "Commitment for rewarding faculty members who strive to accomplish innovative and effective teaching," was also found. Unlike some larger universities whose primary emphasis is on research, the college under study places highest value on effective teaching. The tenure and promotion policy places heavy emphasis on the assessed effectiveness of the faculty member's teaching. A rating of five was assigned to the relationship between the existent and ideal state (see Figure 1, page 58).

The college has a faculty development fund with specific allocation for each faculty member. The presence of this fund offered support of the achievement of the ideal state, "Commitment for the individualized professional growth of faculty members as evidenced by resource allocation for such activities." In addition, a program whereby grant support is actively sought to support faculty growth and a sabbatical leave program are in place. Based upon these findings, a rating of five was assigned to the relationship between the existent and ideal state (see Figure 1, page 58).

The ideal state, "Commitment to use faculty members to their fullest potential in areas of competency," was supported by assessment of teaching responsibilities and committee assignments. For example, the QUE Committee which is exploring computer literacy consists of faculty who possess expertise and a knowledgeable perspective in this area. A rating of five was assigned to the relationship between the existent and ideal state (see Figure 1, page 58).

The thrust of the college's curriculum, initiated in 1970 under the nomenclature of "Achievement 70's: A Program for Individual Achievement," supports the ideal state "Consideration of individual differences in shaping the academic programs and in creating a climate which encourages students to assume increasingly greater responsibility for their individual learning experiences." A rating of four was assigned to the relationship between the existent and ideal state based upon the observation that in actual practice programatic constraints limit full individualization of programs for the majority of students (Figure 1, page 58).

Evidence to support the ideal state, "Commitment for producing exemplary graduates," is inherent in the preceding assessment. In addition, an informal survey of graduates demonstrated a high level of success in graduate or professional studies as well as in business and civic leadership. A rating of five was assigned to the relationship between the existent and ideal state (Figure 1, page 58).

Long-range planning has not been a distinct and deliberate process within the college prior to the current year. As such, most of the assessed efforts in this area were in the formulating of objectives and means of achieving goals. Although the ideal state "Support for increasing resources for technologic advances in education" is evident in the draft materials in this area, actual processes and products are unavailable to assess; therefore, a rating of three was assigned to the relationship between the existent and ideal state (Figure 1, page 58).

The ideal state "Commitment to careful coordination among departments to maximize the potential of resources" was supported. Although this coordination to date has not come directly from the delineated aspects of long-range planning, it has been a product of the administrative style of the top administrative officials of the college and reflects the cogent awareness of limitation of resources. A subjective rating of four was assigned to the relationship between the existent and ideal state based upon the sense that coordination is in place, but could be more effective (See Figure 1, page 58).

Recent developments offered supportive evidence of actualizing the ideal state "Commitment to active participation of departmental chairpersons in decision making and in allocation of resources." A coordination meeting was held by chairpersons of departments who could potentially qualify for a single source of external monies to support their programs. From this meeting, mutual agreements and a strategy for proceeding were developed. In addition, free exchange of information and requests occur among departmental chairpersons and the academic dean. A rating of five was assigned to the relationship between the existent and ideal state (see Figure 1, page 58).

Finally, the area of environment was assessed. A rating of five was assigned to the relationship between the existent and ideal state based upon the frequently demonstrated free exchange of communication among administrators and chairpersons. In addition, the environment vividly demonstrates its acceptance of innovation and change as reflected by a new general education program as well as an evolving Oxbridge tutorial approach to education (See Figure 1, page 58).

A maximum summative score of 60 would be possible for the category of administration if each statement received a rating of five. A majority of areas were assigned a rating of five resulting in a summative score of 56. Based upon data assessed, the descriptive

FIGURE 1

CATEGORY/ELEMENTS	1	2	3	4	5	IDEAL STATE
ADMINISTRATION						
Mission and Goals					X	Recognition of a rapidly changing world and of innovative technologies and their influence on education.
					X	Support for creative, innovative, and effective teaching efforts.
					X	Commitment for rewarding faculty members who strive to accomplish innovative and effective teaching.
					X	Commitment for the individualized professional growth of faculty members as evidenced by resource allocation for such activities.
					X	Commitment to use faculty members to their fullest potential in areas of competence.
				X		Consideration of individual differences in shaping the academic programs and in creating a climate which encourages students to assume increasingly greater responsibility for their individual learning experiences.
					X	Commitment for producing exemplary graduates.
Long-Range Planning			X			Support for increasing resources (funds, facilities, staff) for technologic advances in education.
				X		Commitment to careful coordination among departments to maximize the potential use of resources.
					X	Commitment to active participation of departmental chairpersons in decision-making and in allocation of resources.
Environment					X	Commitment to open and full communication between administrators and chairpersons.
					X	Support for innovation and change in the educational process.

(Columns 1–5: CONSTRAINTS/CAPABILITIES)

DESCRIPTIVE STATEMENT: Administrative elements are strongly supportive of categorical requisites necessary to implement a CAI program.

Maximum Summative Score Possible = 60
Obtained Summative Score = 56

statement generated for this category was: "Administration elements are strongly supportive of categorical requisites necessary to implement a CAI program." In view of the strength of the assessed capabilities, the author determined it unnecessary to develop options for further strengthening of the capabilities.

Because a positive assessment was obtained for the category of administration, the author proceeded to subsequent categories in the schema for decision-making. As was stressed in Chapter III, if a negative assessment had been made for this category, it would have been impossible to proceed further into the decision schema.

Finance

An assessment of available funds for program start-up demonstrated that resources were not currently available within the institution; therefore, a rating of one was assigned to the relationship between the existent and ideal state. Two grants had been written and were ready for submission to two private foundations which had expressed an interest in academic computing in the area of nursing. In view of this fact, a rating of three was given to the relationship between the existent and secondary ideal state of "available resources from an external source." This rating was based upon the reasoning that the grants were developed; however, funding was not assured. The schema presentation for this category is found in Figure 2, page 61.

Assessment also revealed that resources were not currently available within the institution to support program continuance; therefore, a rating of one was assigned to the relationship between the existent and ideal state. Plans were in place to write additional grants to support program continuance during Year One of operation. Such grant activity had been identified as necessary based upon the anticipated need to develop much of the software. A rating of three was assigned to the relationship between the existent and ideal state based upon the reasoning that grants would be developed; however, funding sources are difficult to predict.

The relationship between the existent and the final ideal state in this category, "Structured plan to phase from external to internal monies," received a rating of three. This rating was based upon an assessment of a recognition and commitment at both departmental and college level to find means of accommodating academic computing into the operation budget in the upcoming years. The current restriction of available resources, however, did not seem to warrant a higher rating.

All ratings for this category were at three or below. This obviously represents a major area of concern in terms of an affirmative decision regarding implementation of CAI. An attempt to summate scores in an effort to compare maximum and obtained scores seemed impractical due to the primary and secondary nature of the ideal statements. The descriptive statement generated was: "Major constraints are present in the category of finance; however, enabling means (grants) have been developed and offer strong likelihood of converting the constraints into capabilities."

FIGURE 2

CATEGORY/ELEMENT	CONSTRAINTS/CAPABILITIES 1	2	3	4	5	IDEAL STATE
FINANCE						
Available funds for start-up	X					Resources currently available within the institution.
			X			If not, available resources from an external source.
Available funds for program continuance	X					Resources currently available within the institution.
			X			If not, available resources from an external source.
			X			Structured plan to phase from external to internal monies.

DESCRIPTIVE STATEMENT: Major constraints are present in the category of finance; however, enabling means (grants) have been developed and offer strong likelihood of converting the constraints into capabilities.

Faculty Members

Figure 3 (page 64) presents the schema for this category. Departmental and individual discussions among faculty clearly demonstrated a strong and supportive attitude toward change and innovation specifically related to implementing CAI. The relationship between the existent and ideal state received a rating of five. In regard to the element of current proficiency for implementing a CAI program, only one faculty member was currently qualified to implement; therefore, this relationship was rated as one. Nevertheless, the relationship between the existent and ideal state, "Potential for acquiring or increasing proficiency," received a rating of five based upon educational commitments made by six faculty members. Five faculty members were currently enrolled in doctoral studies, one additional faculty member would begin doctoral work in the Summer, 1981. All expressed a desire to develop increased competence in the area of computing via course work. Group discussion revealed six faculty members planned to attempt to combine their doctoral research activities in such a way as to build educational research in the area of CAI.

In regard to the elements of inservice training, the relationship between the existent and ideal state, "Available resources for inservice training," received a rating of five. This rating was based upon the availability of one faculty member in each of the departments of Nursing, Biology, Physics, Mathematics, Chemistry and Psychology who had computing experience and who indicated a willingness to assist in inservice activities with other faculty. In addition, support personnel for inservice training were included in the grants mentioned previously.

The relationship between the existent and ideal state, "Available time for inservice training without overload or threat to quality of existing programs," was rated as four. This subjective assessment was based upon previous needs for departmental inservice training which were accomplished with minimum disruption of programs but which resulted in some degree of overload.

A rating of one was assigned to the relationship between the existent and the ideal state, "Available time for development of software and implementation without overload or threat to quality of existing programs." This assessment resulted from an awareness of the reported amount of time required to produce software combined with a perception of the current workload for a fixed number of faculty.

The relationship between the existent and ideal state, "Publication or research credit awarded for software development," received a rating of five. The flexibility of the promotion and tenure policy in effect would allow for consideration of this procedure.

A rating of four was assigned to the relationship between the existent and ideal state, "Available and accessible computer expert with appropriate language expertise." As was mentioned earlier, resources were currently available in the faculty; however, their accessibility in this area was limited by their full-time teaching responsibilities.

The relationship between the existent and ideal state, "Interactive and supportive faculty," was rated as five. This rating was based upon past experiences and current observations of interpersonal

FIGURE 3

CATEGORY/ELEMENTS	CONSTRAINTS/CAPABILITIES 1	2	3	4	5	IDEAL STATE
FACULTY MEMBERS						
Supportive attitudes toward change/innovation					X	Supportive attitude toward change and innovation.
Current proficiency for implementing a CAI system	X					Qualified to implement.
Trainability and openness to training					X	Potential for acquiring or increasing proficiency.
Established structure and resources for inservice training					X	Available resources (monies and consultation as needed) for inservice training.
Available usable time in existing workloads				X		Available time for inservice training without overload and/or threat to quality of existing programs.
	X					Available time for development of software and implementation without overload or threat to quality of existing programs.
The reward systems					X	Publication or research credit awarded for software development
Availability of consultants and resources				X		Available and accessible computer expert with appropriate language expertise
Environment						Interactive and supportive faculty.

DESCRIPTIVE STATEMENT: Elements are supportive of requisites necessary to implement a CAI program except for current faculty proficiency and time available for software production.

and group dynamics present within the environment.

Of nine statements in the faculty category, two fell within the area identified as constraints. These two areas were consistent with reported limitations in implementing CAI in higher education generally. The descriptive statement generated for this category was: "Elements are supportive of requisites necessary to implement a CAI program except for current faculty proficiency and time available for software production." Enabling mechanisms are currently in place to ameliorate the lack of faculty proficiency. Strategies need to be developed to provide for time allocation to develop software. Such strategies would most likely include reassessment and potential reassignment of faculty responsibilities, application for external funding for additional support staff, and deliberate use of sabbatical leaves for this purpose.

Students

A survey of current students and their characteristics revealed a relatively heterogenous group. Although not as diverse as might be expected in a larger public institution, variances were definitely present, especially in the area of academic backgrounds. Data regarding learning styles was not readily available to assess. A subjective assessment was made and a rating of four assigned to each relationship between the existent and ideal state in this category. The schema presentation for this category may be found in Figure 4, page 66. Based upon findings of the Review of Literature, the author postulated that CAI could have the effect of maximizing the individualization of

FIGURE 4

CATEGORY/ELEMENTS	CONSTRAINTS/CAPABILITIES 1	2	3	4	5	IDEAL STATE
STUDENTS						
Characteristics:						
-sex				X		Maximum individualization of instruction.
-age						
-academic back-ground				X		Sufficient student maturity and accountability to effectively use the CAI approach.
-learning styles						

DESCRIPTIVE STATEMENT: Elements are supportive of categorical requisites necessary to implement CAI.

CATEGORY/ELEMENTS	1	2	3	4	5	IDEAL STATE
FACILITIES						
Available and adequate	X					Currently available and adequate without construction or renovation.
Construction or renovation needed			X	or	X	Resources currently available to support construction or renovation.
				X	or X	Renovation or construction possible without disruption of existing programs.
Availability				X	or X	Facility available to students for their maximum access.

DESCRIPTIVE STATEMENT: Elements regarding construction or renovation and facility availability are supportive of categorical requisites necessary to implement CAI.

instruction; however, a rating of five for this relationship did not appear to have substantiation at this time. Most students have had varying degrees of exposure to some form of personalized system of instruction by nature of the teaching methodologies employed in several prerequisite courses for nursing. Some students have performed exceptionally well with this approach while others have experienced difficulty in self-discipline and direction. Because of the relatedness of these approaches to CAI, an assumption was made that a similar pattern would emerge; therefore, a rating of four was assigned to the relationship between the existent and ideal state regarding student maturity. The descriptive statement generated for this category was: "Elements are supportive of categorical requisites necessary to implement CAI." Because of the consistent strength of the ratings, the author determined that generation of options to strengthen the capabilities was not necessary. An observation of the need to collect data regarding student learning styles was noted.

Facilities

The schema for this category is presented in Figure 4, page 66. The relationship between the existent and the ideal statement, "Currently available and adequate without construction or renovation," was assigned a rating of one. This assessment was based upon a careful survey by the QUE Committee of available space on campus for academic computing. Essentially, no space is currently available. Two viable alternatives have been identified. The prime alternative is to construct a computer laboratory in a vacant building which is scheduled for renovation within the coming year. Resources have been garnered for this renovation; therefore, the relationship between the existent and the ideal statement which implies that resources are available to support renovation would be rated as five.

An alternative location for academic computing was identified within the library building. If this site were selected, a rating of three would be assigned to the relationship between the existent and the ideal state of available resources to support renovation. This rating would be based upon the fact that these monies would have to come from grant funds. Grants have been written, but not yet funded.

A rating of five would be assigned to the relationship between the existent and ideal state regarding renovation without disruption of existing programs if the vacant building were selected as the site of the computer laboratory. A rating of four would be assigned if the library were selected as the site. Major disruption would not occur with renovation in the library, but some inconvenience and rearrangements would be necessitated.

The relationship between the existent and ideal state regarding maximum availability of the facility for student use would receive a rating of five if the library site were selected. This rating would be based upon the obvious fact that the computer would be available at any hour that the library is open. A rating of four would be assigned to this relationship if the vacant building were selected. This rating would be based upon the notion that the computer laboratory would be open on similar hours as the library with student supervision; however, this is not a firmly established commitment as yet and would obviously require additional resources.

The descriptive statement generated for this category was: "Elements regarding construction or renovation and facility availability are supportive of categorical requisites necessary to implement CAI." Mechanisms were already in progress at the college level to strengthen capabilities in this area; therefore, additional options are not deemed necessary.

Equipment

Presentation of this portion of the schema is found in Figure 5, page 72. The relationship between the existent and ideal state, "Available within the institution," was rated as five. This rating was based upon the availability of a faculty member in the department of physics who is considered an international authority on microcomputers. As was discussed in the Faculty Member category, there are five additional faculty who have had experiences in academic computing and who could guide decisions with appropriate questions. The second statement, "If not, available and obtainable from external sources," should also be rated in view of the fact that two sources were available. A consultant was made available to the college through its participation in Project QUE. In addition, a form of consultation was available through an area computer distributor. Although this distributor had vested interest in selling hardware, he was most assistive in exploring various systems. Based upon this data, a rating of five was assigned to the relationship between the existent and ideal state.

A rating of one was assigned to the relationship between the existent and ideal state which implies that hardware is currently in place. This assessment was based upon the fact that computer resources for the college under study were exceptionally limited. The math department had a small computer system which was committed to use by students in the area of computer programming; two APPLE microcomputers were also present but committed to full-time use by business, chemistry, and biology students. The existent resources of the college could not support purchase of additional computers; therefore, a rating of one was assigned to this relationship. As was discussed earlier, two grants which would provide resources to obtain the necessary hardware had been formulated and were ready for submission. A rating of three was assigned to this relationship between existent and ideal state based upon the judgment that the grants were established; however, funding was not assured.

The relationship between the existent and ideal state, "Installation done without disruption of existing programs," was assigned a value of four or five. The variable rating was due to the questions generated in the discussion of facilities. If the final decision were made to place the computer in the library, a rating of four would be assigned. This rating was based upon the fact that programs would continue with minimal inconvenience. A rating of five would be assigned if the computer were placed in the vacant building. The relationship between the existent and ideal state, "Installation assures initially functional system," was rated as five based upon the presence of a pending vendor's contract which offers this assurance.

A rating of three was assigned to the relationship between the existent and ideal state regarding a responsive service contract. This rating was based upon the assessment that such contracts were available; however, the cost of such a contract is extremely high. This presents an additional demand in the area of resources needed to start and continue a CAI program. A positive assessment could not be made at this time due to lack of knowledge regarding the availability of these resources.

A rating of five was assigned to the relationship between the existent and ideal states associated with the element of system expansion. The systems that were under serious consideration had the capability for expansion without major demand for additional resources or disruption of existing programs.

The relationship between the existent and ideal state regarding available and obtainable software received a rating of one. The only relevant source of software found was through Ohio State University. The materials available were limited in number and scope. The relationship between the existent and secondary ideal state, "If not, resources available for supporting development by faculty," was assigned a rating of four. This rating was based upon the fact that current faculty expertise could support initiation of efforts in this area, but would face limitations both in level of expertise and time available.

The descriptive statement generated was: "Major constraints related to the availability of resources are present in this category; nevertheless, enabling means (grants) have been developed and offer strong likelihood of converting constraints into capabilities." Additional option generation was not deemed necessary.

FIGURE 5

CATEGORY/ELEMENTS	CONSTRAINTS/CAPABILITIES 1	2	3	4	5	IDEAL STATE
EQUIPMENT (Hardware & Software)						
Availability of consultant expertise					X	Available within the institution.
					X	If not available, obtainable from external sources.
Availability of appropriate hardware	X					Hardware currently in place and compatible with CAI dynamics.
	X					If not, obtainable with existent resources.
			X			If not, obtainable by external funding.
Installation				X or	X	Installation done without disruption of existing programs.
					X	Installation assures initially functional system.
Service contract			X			Responsive service contract in place to minimize extended periods of equipment failure.
Capacity of system expansion					X	Easily achieved with minimal demand for additional resources.
					X	Expansion accomplished without disruption of existing program.
Availability of software	X					Software available and obtainable.
				X		If not, resources available for supporting development by faculty.

DESCRIPTIVE STATEMENT: Major constraints related to the availability of resources are present in this category; nevertheless, enabling means (grants) have been developed and offer strong likelihood of converting constraints into capabilities.

Summary

Chapter IV has presented the application of the decision schema to a small, private, liberal arts college's department of nursing. The decision schema was found to be functional and helpful in guiding the administrator through the decision process. Application of the schema revealed that of the six categories assessed, two (Finance and Equipment) were found to present major constraining forces. These constraining forces could be converted into capabilities upon funding of either grant which had been written. The decision to implement CAI in the program under study was therefore affirmative, but predicated upon the receipt of external funding. This decision should offer further guidance and support to the nurse administrator in aggressive pursuit of assistance from the college's Grants Office.

Conclusions and recommendations will be presented in Chapter V.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to construct a decision-making model or schema for implementation of CAI into baccalaureate nursing programs. Chapter I presented the background for the study by summarizing the current status of academic computing in higher education generally and then specifically in nursing education. Chapter II presented a brief consideration of the impact of technology on education, teaching and learning, and nursing. A comprehensive review of computer use in instruction and CAI specifically was presented. An overview of the evolution of CAI, its relation to programmed instruction, CAI modes, its advantages and limitations, CAI hardware and software issues, its effect on teaching and learning, staffing implications with CAI, and the current applications of CAI in nursing was considered. In addition, administrative considerations in implementing instructional innovations and key elements in decision-making were presented.

The processes involved in constructing the decision schema were presented in Chapter III. Six major categories of decisions to be made were identified: administration, finance, faculty members, students, facilities, and equipment. Essential elements within each category were specified, and associated "ideal state" statements were developed. These statements contained requisites for program start-up. A type of force field analysis was developed to allow the administrator to rank the relative strength of constraints and capabilities for each category and associated elements within her/his institution as compared to the "ideal state".

Application of the decision schema to a small, private, liberal arts college's department of nursing was presented in Chapter IV. Incorporated into this chapter were the sources of data which were considered in the decision-making process.

Conclusions

The decision schema was found to be functional and helpful in guiding the administrator through the decision process. Although many of the rankings were subjectively based, the process involved brought clarity to the decision-making environment and assisted in the identification of related options. An affirmative decision to implement CAI in the program under study, predicated upon receipt of external funding, evolved.

The categories demonstrating major constraining forces for the program under study were Finance and Equipment. Other potentially problematic areas identified were lack of faculty proficiency in computing, lack of available software, and limitation of available faculty time to develop needed software. All of these findings were consistent with factors limiting the implementing of CAI as reported in the literature. Enabling options (external funding) were identified in order to consider means whereby constraints could be converted into capabilities.

Recommendations

Rigid application of the schema should not be attempted, rather individualization or modification to each specific situation should be considered. Further efforts in developing a cybernetic decision-making model regarding CAI implementation should be pursued. Such development would allow for important feedback loops missing in the present schema.

It is further recommended that:

1. Methodologies be developed to effectively and efficiently increase faculty proficiency in the area of academic computing.

2. Methodologies be developed to enhance or maximize freed time for development of software by faculty.

3. Careful and deliberate planning be undertaken for program-wide applications of CAI rather than sporadic unit or module application.

4. Research be undertaken in areas of learning and teaching as they relate to CAI (e.g., retention, transfer, cognitive style, efficiency and effectiveness of learning, effect of change on traditional teaching roles).

5. Research be undertaken to assess cost effectiveness and cost benefits of CAI versus traditional instruction.

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APPENDIX A

THE DECISION SCHEMA

CATEGORY/ELEMENTS	CONSTRAINTS/CAPABILITIES 1	2	3	4	5	IDEAL STATE
ADMINISTRATION						
Mission and Goals						Recognition of a rapidly changing world and of innovative technologies and their influence on education.
						Support for creative, innovative and effective teaching efforts.
						Commitment for rewarding faculty members who strive to accomplish innovative and effective teaching.
						Commitment for the individualized professional growth of faculty members as evidenced by resource allocation for such activities.
						Commitment to use faculty members to their fullest potential in areas of competence.
						Consideration of individual differences in shaping the academic programs and in creating a climate which encourages students to assume increasingly greater responsibility for their individual learning experiences.
						Commitment for producing exemplary graduates.
Long-Range Planning						Support for increasing resources (funds, facilities, staff) for technologic advances in education.
						Commitment to careful coordination among departments to maximize the potential use of resources.
						Commitment to active participation of departmental chairpersons in decision-making and in allocation of resources.
Environment						Commitment to open and full communication between administrators and chairpersons.
						Support for innovation and change in the educational process.

CATEGORY/ELEMENT	CONSTRAINTS/CAPABILITIES 1	2	3	4	5	IDEAL STATE
<u>FINANCE</u>						
Available funds for start-up						Resources currently available within the institution. If not, available resources from an external source.
Available funds for program continuance						Resources currently available within the institution. If not, available resources from an external source. Structured plan to phase from external to internal monies.

CATEGORY/ELEMENTS	CONSTRAINTS/CAPABILITIES 1	2	3	4	5	IDEAL STATE
FACULTY MEMBERS						
Supportive attitudes toward change/innovation						Supportive attitude toward change and innovation.
Current proficiency for implementing a CAI system						Qualified to implement.
Trainability and openness to training						Potential for acquiring or increasing proficiency.
Established structure and resources for inservice training						Available resources (monies and consultation as needed) for inservice training.
Available usable time in existing workloads						Available time for inservice training without overload and/or threat to quality of existing programs.
						Available time for development of software and implementation without overload or threat to quality of existing programs.
The reward systems						Publication or research credit awarded for software development
Availability of consultants and resources						Available and accessible computer expert with appropriate language expertise
Environment						Interactive and supportive faculty.

CATEGORY/ELEMENTS	CONSTRAINTS/CAPABILITIES					IDEAL STATE
	1	2	3	4	5	
STUDENTS						
Characteristics: -sex -age -academic back-ground -learning styles						Maximum individualization of instruction. Sufficient student maturity and accountability to effectively use the CAI approach.
FACILITIES						
Available and adequate						Currently available and adequate without construction or renovation.
Construction or renovation needed						Resources currently available to support construction or renovation. Renovation or construction possible without disruption of existing programs.
Availability						Facility available to students for their maximum access.

CATEGORY/ELEMENTS	CONSTRAINTS/CAPABILITIES					IDEAL STATE
	1	2	3	4	5	
<u>EQUIPMENT</u> (Hardware & Software)						
Availability of consultant expertise						Available within the institution. If not available, obtainable from external sources.
Availability of appropriate hardware						Hardware currently in place and compatible with CAI dynamics. If not, obtainable with existent resources. If not, obtainable by external funding.
Installation						Installation done without disruption of existing programs. Installation assures initially functional system.
Service contract						Responsive service contract in place to minimize down-time.
Capacity of system expansion						Easily achieved with minimal demand for additional resources. Expansion accomplished without disruption of existing program.
Availability of software						Software available and obtainable. If not, resources available for supporting development by faculty.

APPENDIX B

AN APPLICATION OF THE DECISION SCHEMA

FIGURE 1

CATEGORY/ELEMENTS	CONSTRAINTS/CAPABILITIES 1	2	3	4	5	IDEAL STATE
ADMINISTRATION						
Mission and Goals					X	Recognition of a rapidly changing world and of innovative technologies and their influence on education.
					X	Support for creative, innovative, and effective teaching efforts.
					X	Commitment for rewarding faculty members who strive to accomplish innovative and effective teaching.
					X	Commitment for the individualized professional growth of faculty members as evidenced by resource allocation for such activities.
					X	Commitment to use faculty members to their fullest potential in areas of competence.
				X		Consideration of individual differences in shaping the academic programs and in creating a climate which encourages students to assume increasingly greater responsibility for their individual learning experiences.
					X	Commitment for producing exemplary graduates.
Long-Range Planning			X			Support for increasing resources (funds, facilities, staff) for technologic advances in education.
				X		Commitment to careful coordination among departments to maximize the potential use of resources.
					X	Commitment to active participation of departmental chairpersons in decision-making and in allocation of resources.
Environment					X	Commitment to open and full communication between administrators and chairpersons.
					X	Support for innovation and change in the educational process.

DESCRIPTIVE STATEMENT: Administrative elements are strongly supportive of categorical requisites necessary to implement a CAI program.

Maximum Summative Score Possible = 60
Obtained Summative Score = 56

FIGURE 2

CATEGORY/ELEMENT	CONSTRAINTS/CAPABILITIES 1	2	3	4	5	IDEAL STATE
FINANCE						
Available funds for start-up	X					Resources currently available within the institution.
			X			If not, available resources from an external source.
Available funds for program continuance	X					Resources currently available within the institution.
			X			If not, available resources from an external source.
			X			Structured plan to phase from external to internal monies.

DESCRIPTIVE STATEMENT: Major constraints are present in the category of finance; however, enabling means (grants) have been developed and offer strong likelihood of converting the constraints into capabilities.

FIGURE 3

CATEGORY/ELEMENTS	CONSTRAINTS/CAPABILITIES 1	2	3	4	5	IDEAL STATE
FACULTY MEMBERS						
Supportive attitudes toward change/innovation					X	Supportive attitude toward change and innovation.
Current proficiency for implementing a CAI system	X					Qualified to implement.
Trainability and openness to training					X	Potential for acquiring or increasing proficiency.
Established structure and resources for inservice training					X	Available resources (monies and consultation as needed) for inservice training.
Available usable time in existing workloads				X		Available time for inservice training without overload and/or threat to quality of existing programs.
	X					Available time for development of software and implementation without overload or threat to quality of existing programs.
The reward systems					X	Publication or research credit awarded for software development
Availability of consultants and resources				X		Available and accessible computer expert with appropriate language expertise
Environment						Interactive and supportive faculty.

DESCRIPTIVE STATEMENT: Elements are supportive of requisites necessary to implement a CAI program except for current faculty proficiency and time available for software production.

FIGURE 4

CATEGORY/ELEMENTS	CONSTRAINTS/CAPABILITIES 1	2	3	4	5	IDEAL STATE
Characteristics: -sex -age -academic back-ground -learning styles				X		Maximum individualization of instruction.
				X		Sufficient student maturity and accountability to effectively use the CAI approach.

DESCRIPTIVE STATEMENT: Elements are supportive of categorical requisites necessary to implement CAI.

CATEGORY/ELEMENTS	1	2	3	4	5	IDEAL STATE
FACILITIES						
Available and adequate	X					Currently available and adequate without construction or renovation.
Construction or renovation needed			X	or	X	Resources currently available to support construction or renovation.
				X	or X	Renovation or construction possible without disruption of existing programs.
Availability				X	or X	Facility available to students for their maximum access.

DESCRIPTIVE STATEMENT: Elements regarding construction or renovation and facility availability are supportive of categorical requisites necessary to implement CAI.

FIGURE 5

CATEGORY/ELEMENTS	CONSTRAINTS/CAPABILITIES					IDEAL STATE
	1	2	3	4	5	
EQUIPMENT (Hardware & Software)						
Availability of consultant expertise					X	Available within the institution.
					X	If not available, obtainable from external sources.
Availability of appropriate hardware	X					Hardware currently in place and compatible with CAI dynamics.
	X					If not, obtainable with existent resources.
			X			If not, obtainable by external funding.
Installation				X or	X	Installation done without disruption of existing programs.
					X	Installation assures initially functional system.
Service contract			X			Responsive service contract in place to minimize extended periods of equipment failure.
Capacity of system expansion					X	Easily achieved with minimal demand for additional resources.
					X	Expansion accomplished without disruption of existing program.
Availability of software	X					Software available and obtainable.
				X		If not, resources available for supporting development by faculty.

DESCRIPTIVE STATEMENT: Major constraints related to the availability of resources are present in this category; nevertheless, enabling means (grants) have been developed and offer strong likelihood of converting constraints into capabilities.